# High Impact Weather Forecasts and Warnings with the Geostationary Lightning Mapper

**Steven Goodman**

**GOES-R Program Senior Scientist**

**NOAA/NESDIS**

**http://www.goes-r.gov**

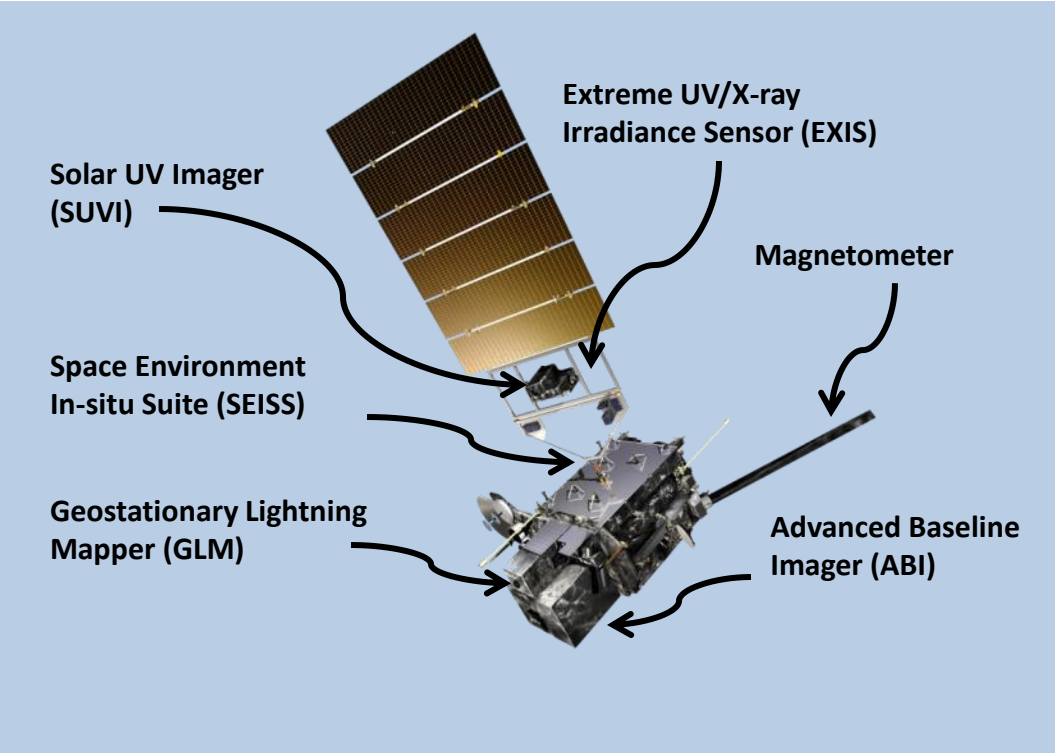
**(with contributions from our many partners)**

Southern Thunder 2011
Norman, OK
11-14 July, 2011

# GOES-R Spacecraft

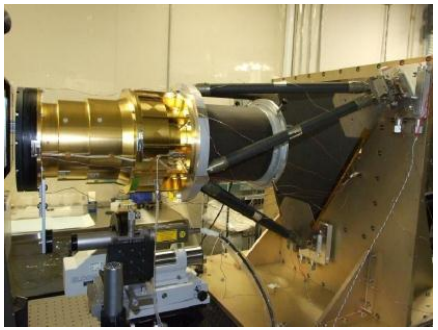
**Specifications**

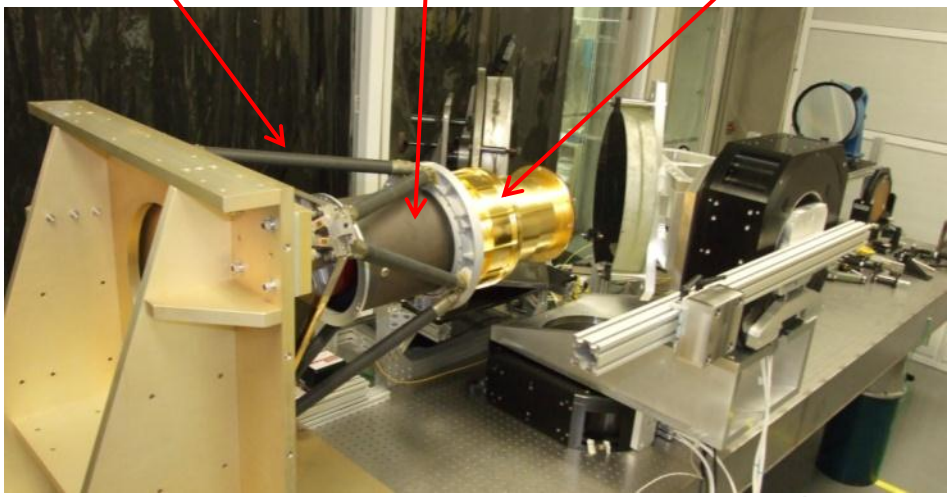
- **Size:** ~5.5 meters (from launch vehicle interface to top of ABI)
- **Mass:** Satellite (spacecraft and payloads) dry mass <2800kg
- **Power Capacity:** >4000W at end-of-life (includes accounting for limited array degradation)
- Spacecraft on-orbit life of 15 years with orbit East-West and North-South position maintained to within +/-0.1 degree
- 3-axis stabilized




Lockheed Martin Space Systems Co (LMSSC) of Newtown, PA is primary contractor

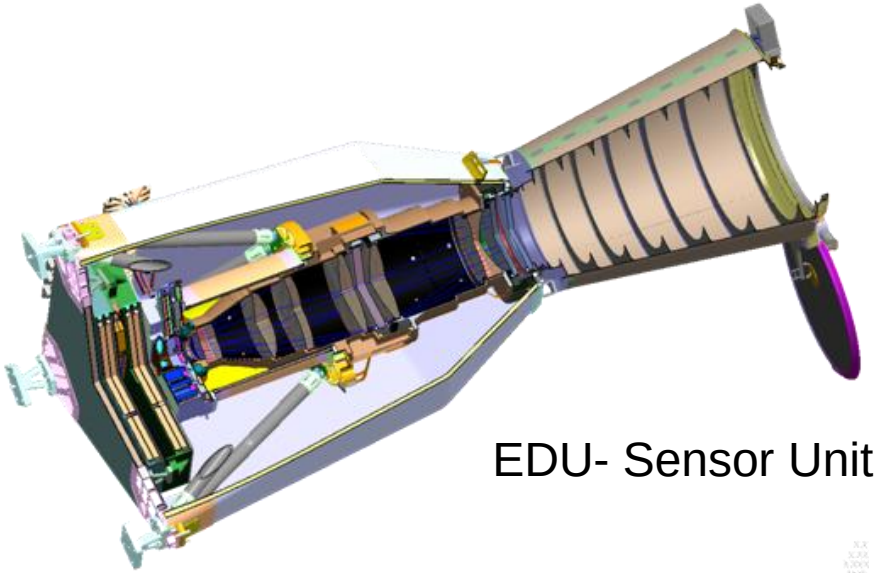
# Geostationary Lightning Mapper (GLM)





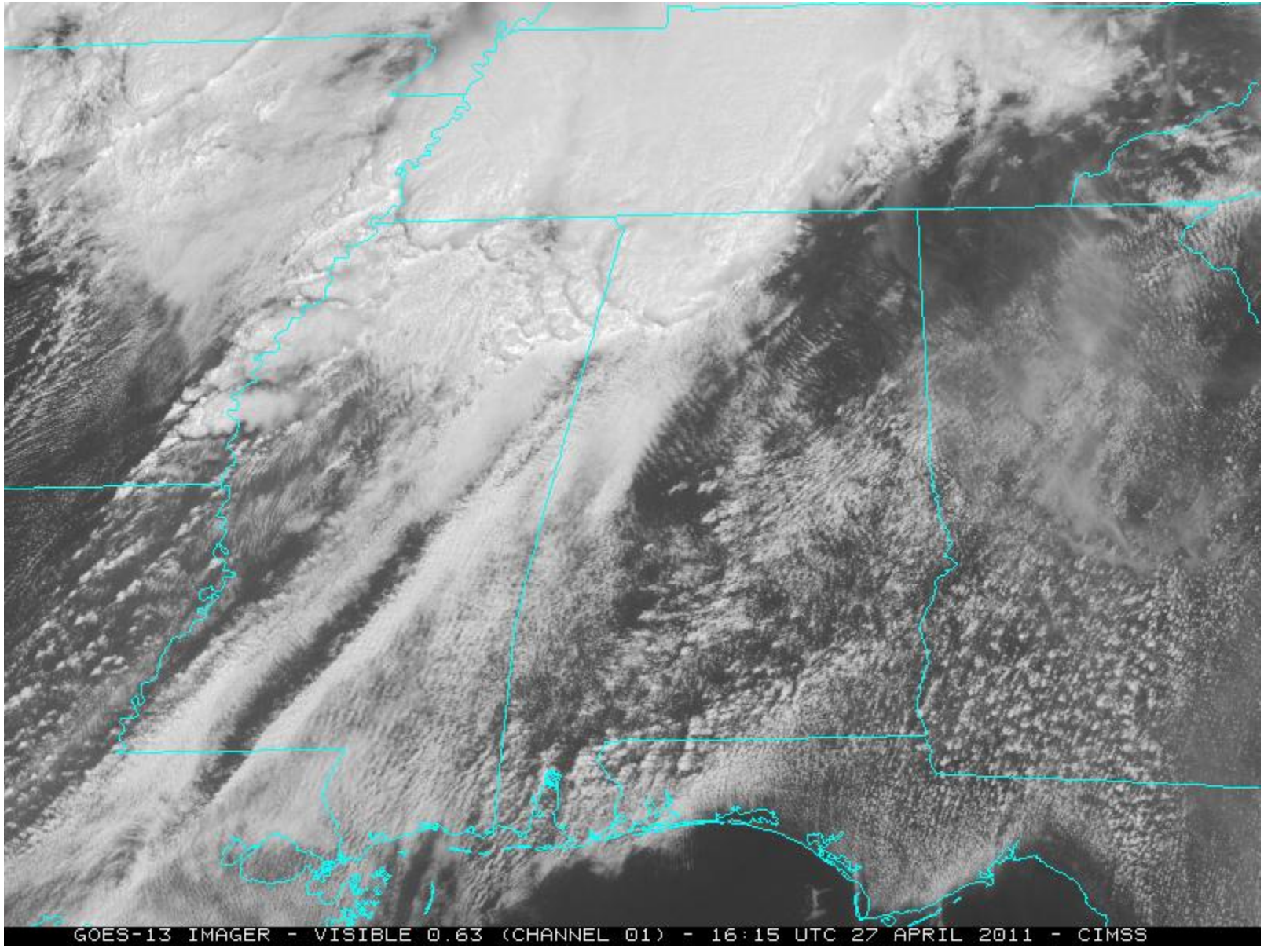

**Specifications**

- **Detects total lightning**: in-cloud, cloud-to-cloud, and cloud-to-ground
- 70-90% flash detection day and night
- Near uniform spatial resolution W. Hemisphere
- Aids in forecasting severe storms and tornado activity, and convective weather impacts on aviation safety and efficiency
- FM-1 I&T begins June 2012
- Ships March 2013
- Launch Oct 2015

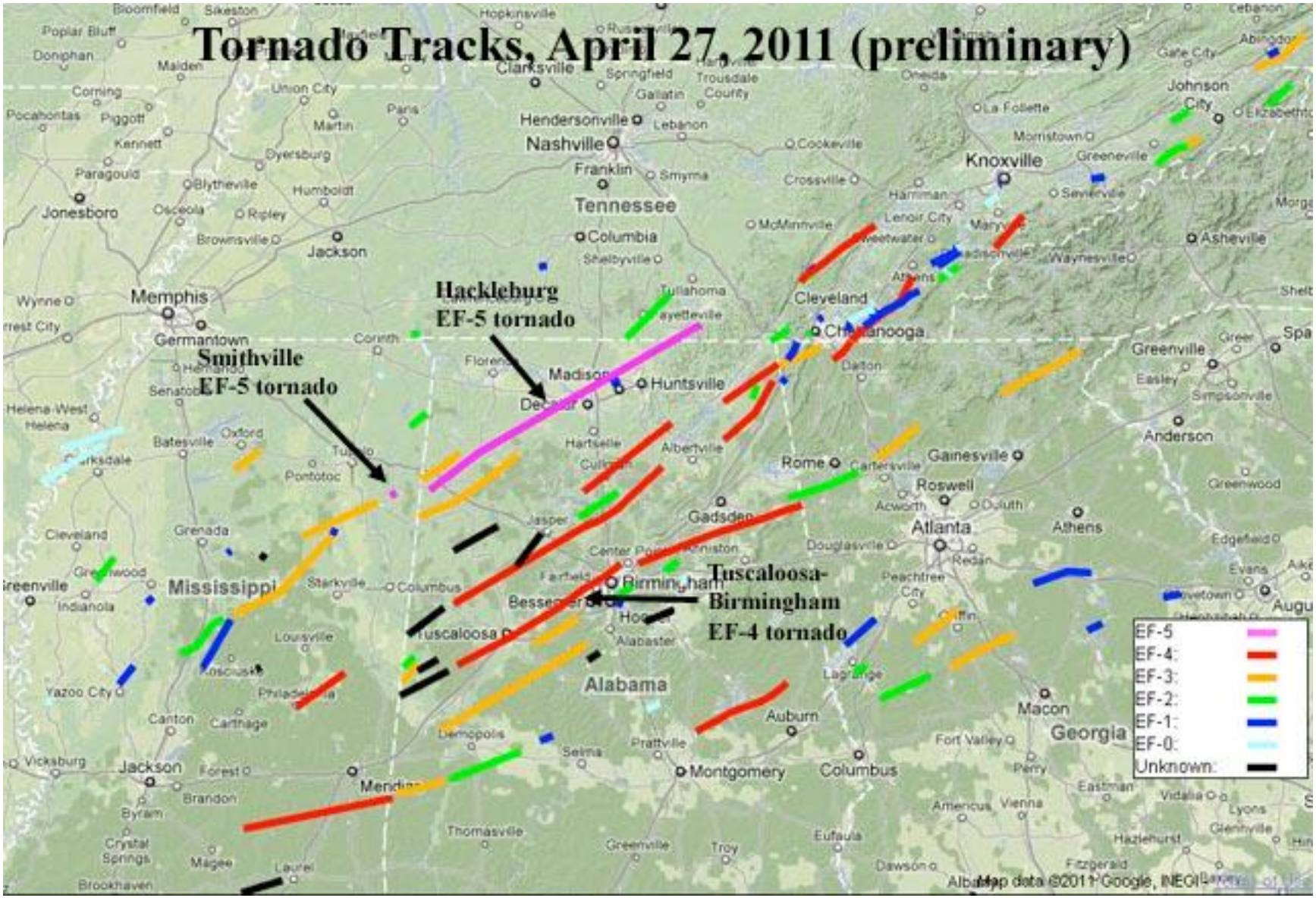


EDU- Sensor Unit

# Southeast US Tornado Outbreak
# 27 April 2011

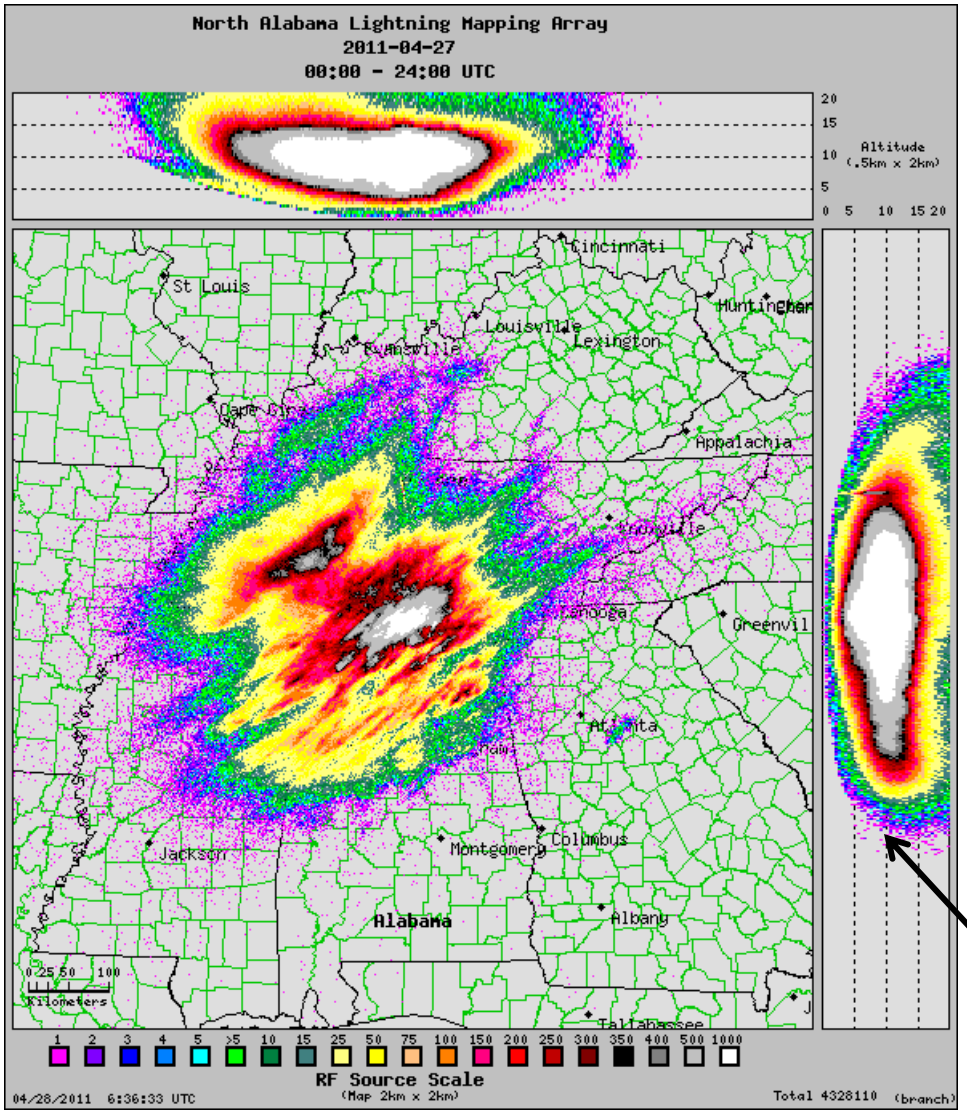


# April 27 Outbreak Tornado Tracks



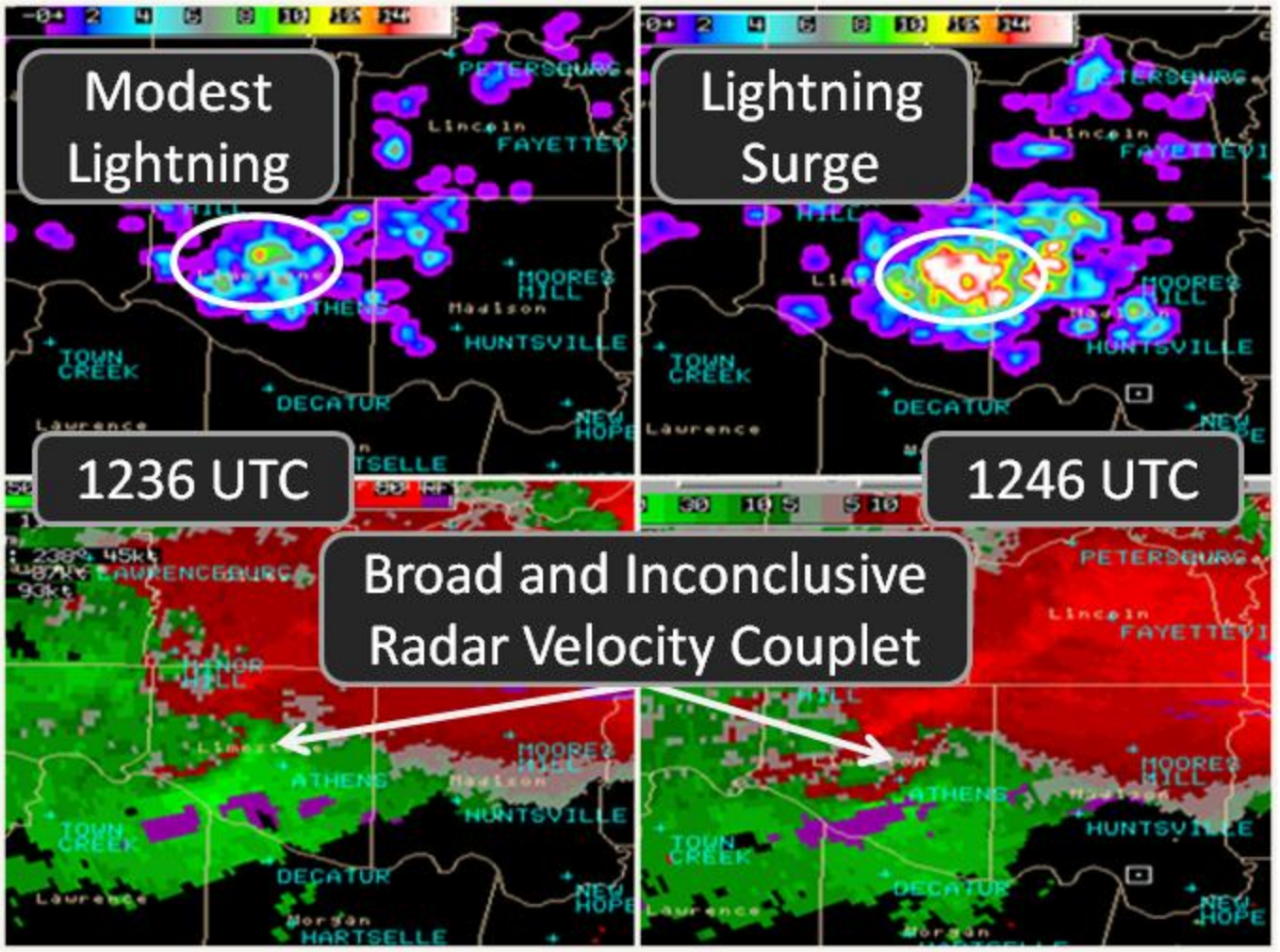
# NALMA 04/27/11

North Alabama VHF Lightning 13-station Mapping Array



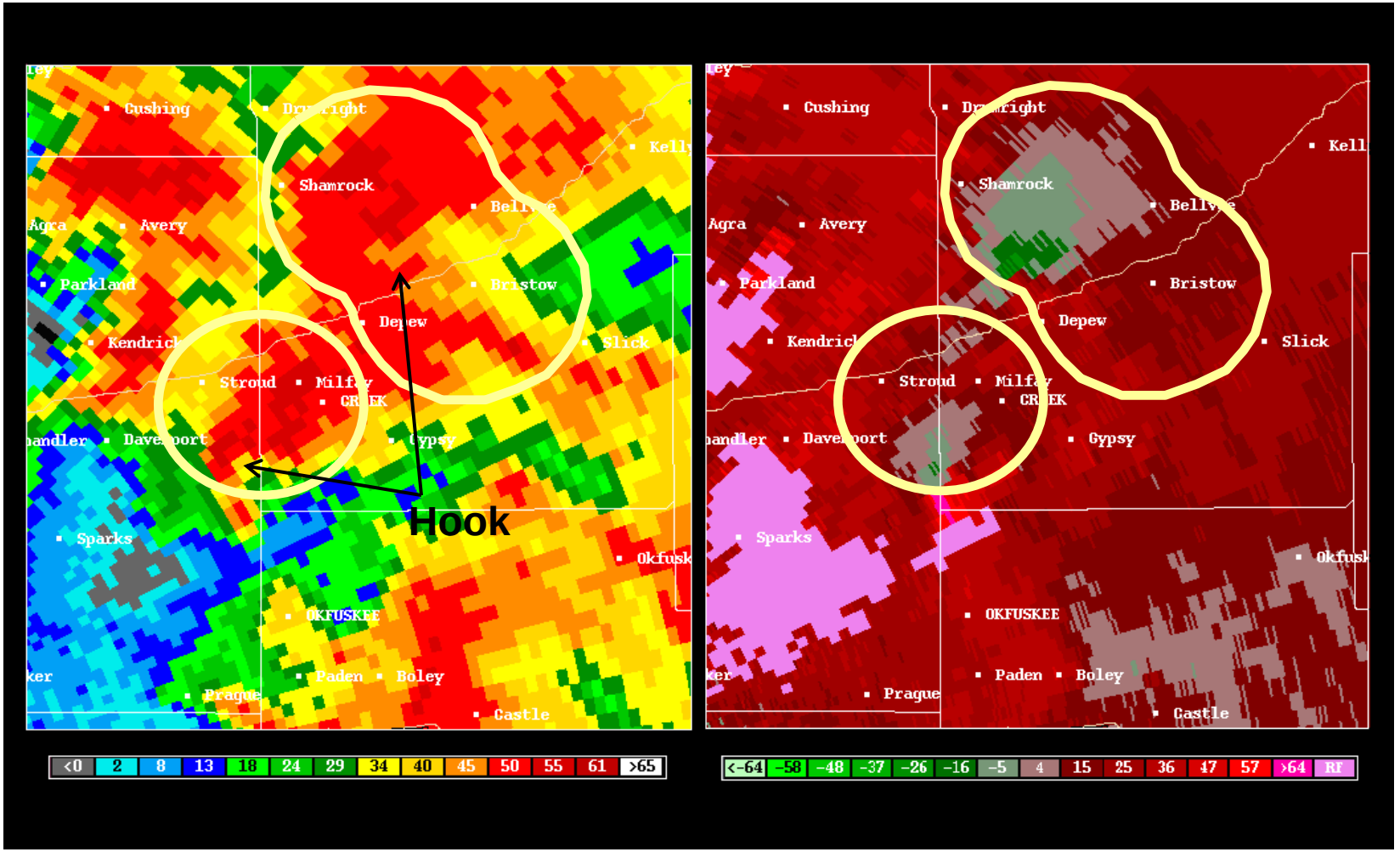

Range ~200 km
limited by line of sight

# Total Lightning Increases with Storm Growth and Updraft Intensification



# OK Tornado Outbreak 3 May 1999

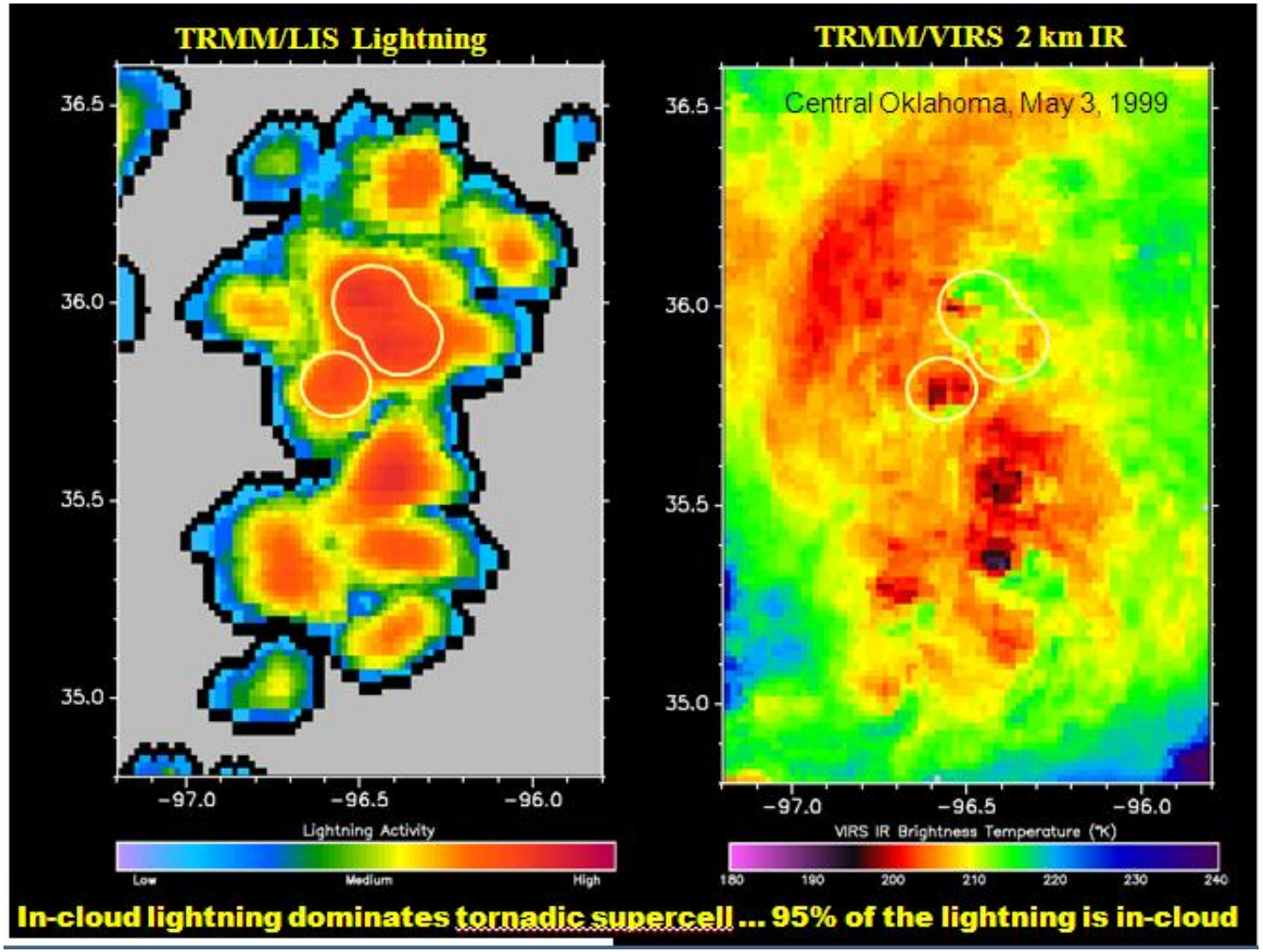
**NEXRAD Reflectivity** **NEXRAD Velocity**




Active lightning region in tornadic supercell … correlates with radar hook echo and velocity couplet

# Total Lightning During OK Tornado Outbreak 3 May 1999

GLM and ABI Combined (with radar) characterizes storm intensification and decay)



# GOES-R Proving Ground

- Collaborative effort between the GOES-R Program Office, selected NOAA/ NASA Cooperative Institutes, NWS forecast offices, NCEP National Centers, JCSDA, and NOAA Testbeds
- Responsible for user readiness testing of GOES-R baseline/option-2 products prior to launch
- Where proxy and simulated GOES-R products are tested, evaluated, and integrated into operations before the GOES-R launch
  - Satellite Champions at NWS National Centers
  - Develop training for users
  - Prepare for display within AWIPS/AWIPS-II/N-AWIPS
- Provide feedback to product developers on experimental day-2 satellite products
- Initial focus on High Impact Weather-warning related products
- A key element of GOES-R User Readiness (Risk Mitigation)

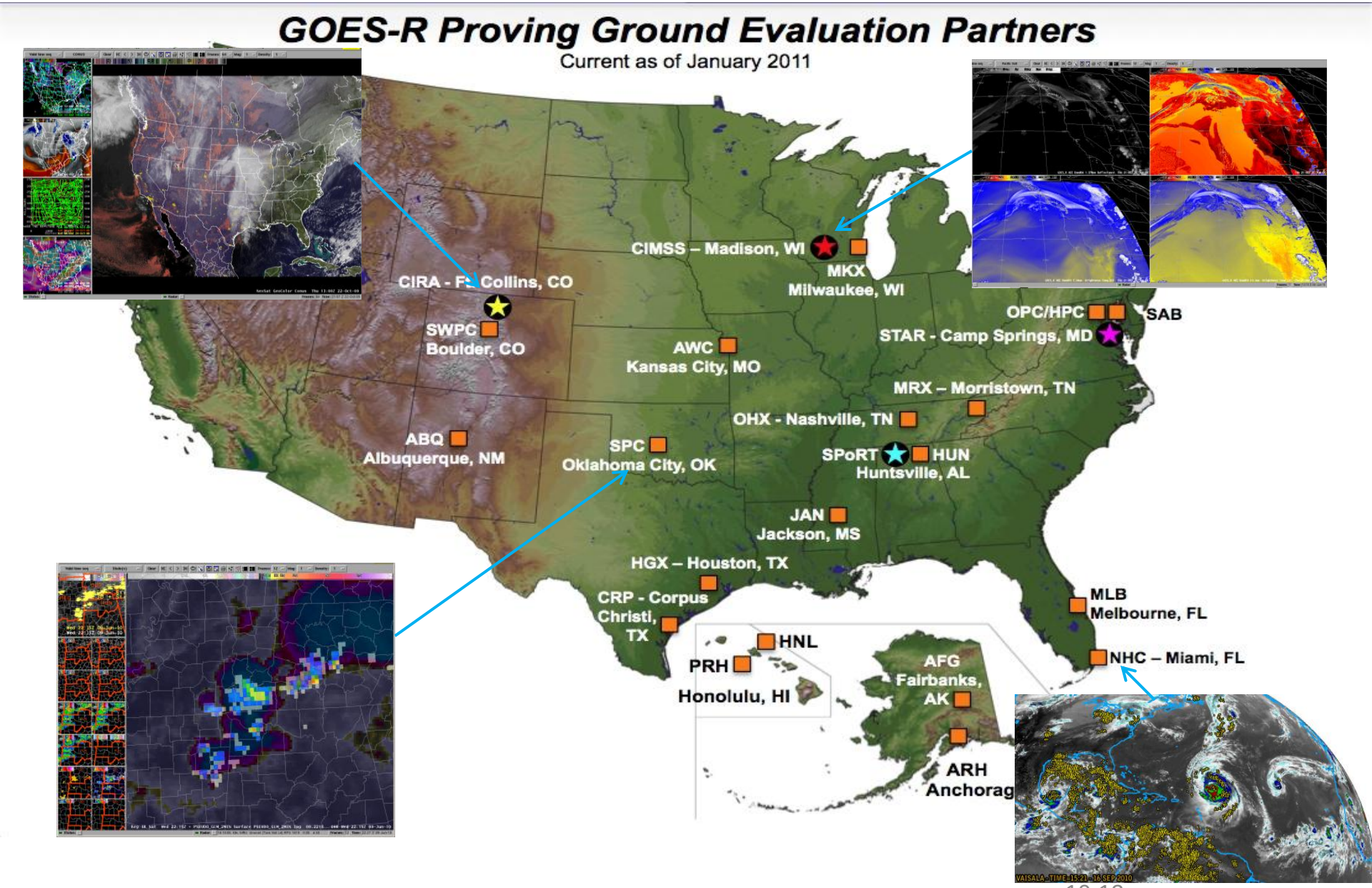
# GOES-R Warning Product Set

Initial focus on products that offer NWS near-real time Warning Related utility.

**Products:**

- Cloud and Moisture Imagery
- Hurricane Intensity
- Lightning Detection: Events, Groups & Flashes
- Rainfall Rate / QPE
- Total Precipitable Water
- Fire/Hot Spot Characterization
- Aircraft Icing Threat
- Trop. Fold Turbulence Prediction
- Volcanic Ash: Detection & Height
- Convective Initiation
- Enhanced “V” / Overshooting Top Detection
- Low Cloud and Fog
- $SO_2$ Detection

# GOES-R Proving Ground

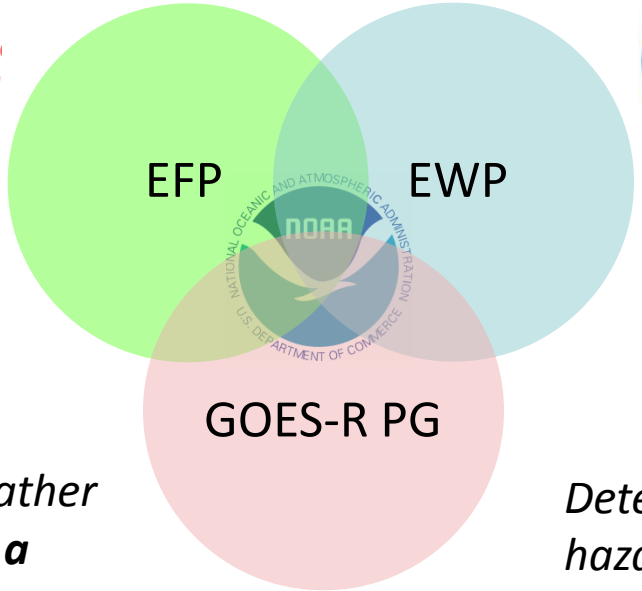


# NOAA's Hazardous Weather Testbed

Storm Prediction Center
Norman, Oklahoma

**E**xperimental
**F**orecast
**P**rogram

*Prediction of hazardous weather events from **a few hours to a week in advance***



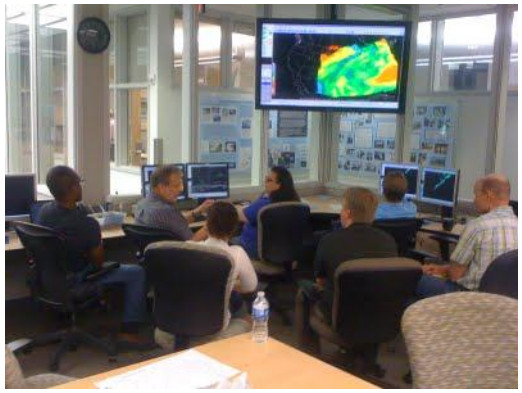

NATIONAL SEVERE STORMS LABORATORY
U.S. DEPARTMENT of COMMERCE
NATIONAL OCEANIC and ATMOSPHERIC ADMINISTRATION

**E**xperimental
**W**arning
**P**rogram

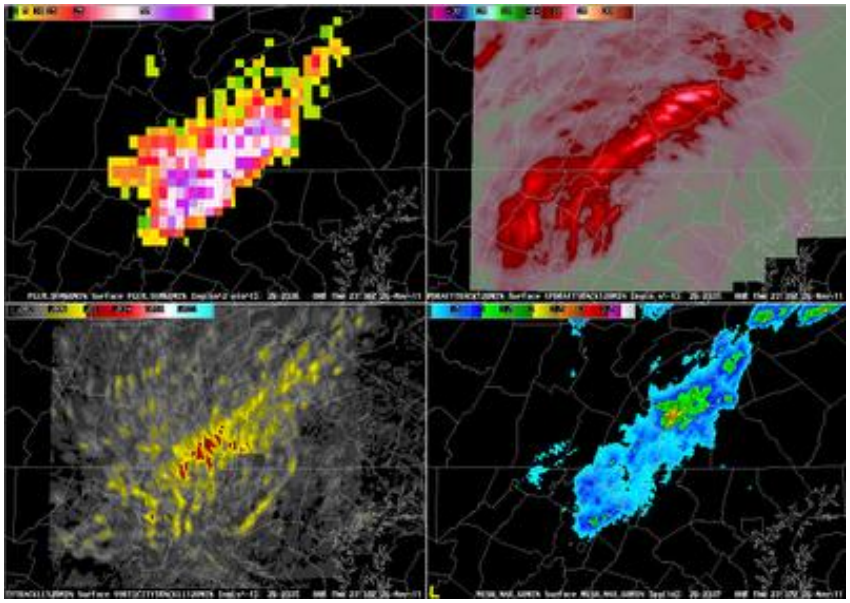
*Detection and prediction of hazardous weather events **up to several hours in advance***

GEOSTATIONARY OPERATIONAL ENVIRONMENTAL SATELLITE R-SERIES
GOES R
NOAA ~ NASA

# HWT: Forecaster Feedback from 2011



- It could help you focus on the new electrification of the storm as well as where new cells might develop or updrafts cores move... would give 10-15 minutes lead time before it showed on radar.
- (Thursday event - OK) Flash rates would pick up a short time before increases in reflectivity.
- (May 19) One of the more interesting features they have been picking up on is the consistent signals between the pGLM lightning trends and values from the MESH (Maximum Expected Size of Hail) algorithm as well as the 3D-Var derived updraft fields.
- Was useful for diagnosing lightning danger... get a lot of calls from the public regarding that within the WFO
- 10-15 minutes lead time on the first CG.



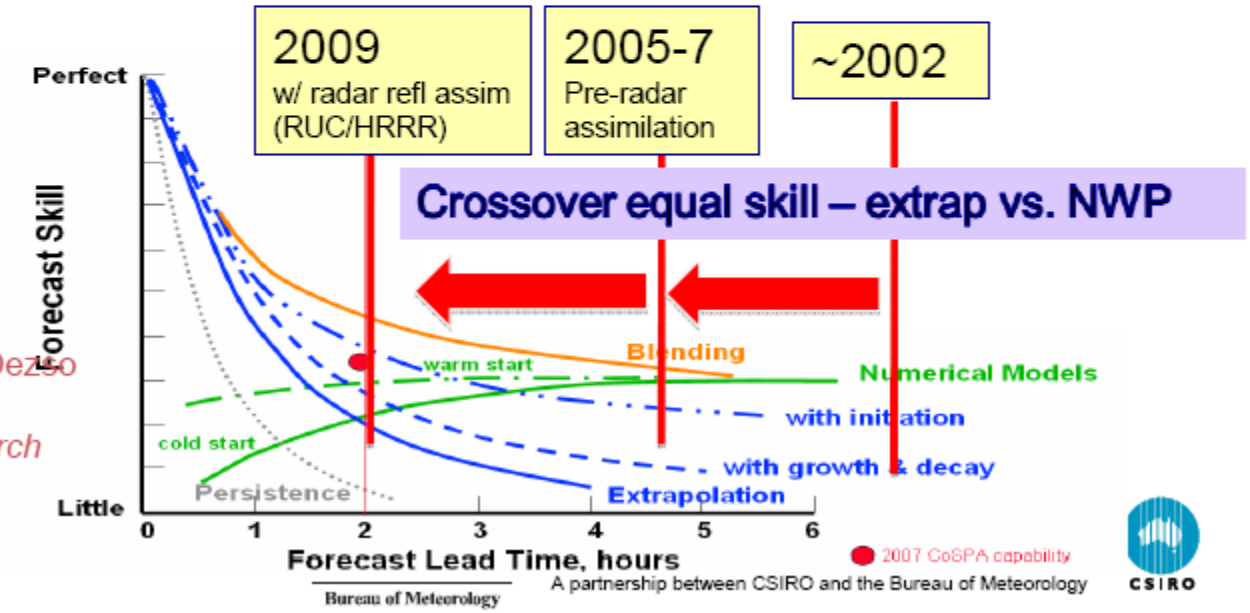
Screen capture illustrates four panel displays used to compare individual products in AWIPS. The pseudo-GLM products often were plotted alongside the 3-D Var updraft and vorticity tracks, as well as the multi-radar multi-sensor hail swaths and reflectivity at -10 C.

http://goesrhwt.blogspot.com

# Bridging (and Shrinking) the Gap Between Extrapolation/Expert Systems and NWP

(From the WSN09 WMO Nowcasting Symposium, Whistler, BC Canada)

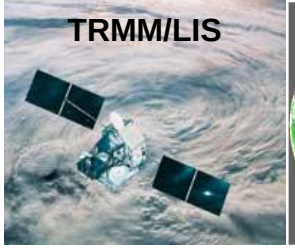
- ***"Since the 0-6 hour period spans the timeframe where both traditional Nowcasting techniques and Numerical Weather Prediction (NWP) can contribute useful information, both approaches will be covered at the Symposium as well as methods that combine Nowcasting and NWP. "***
- 2009 status
  - NWP, blending, nowcasting methods have all improved since WSN05 (Toulouse, 2005)
  - Crossover time between NWP and nowcasting is now smaller




**WSN09 Stan Benjamin** –
Ming Hu, Steve Weygandt, Dezso Devenyi
*NOAA Earth System Research Lab (ESRL)*
*Boulder, Colorado USA*

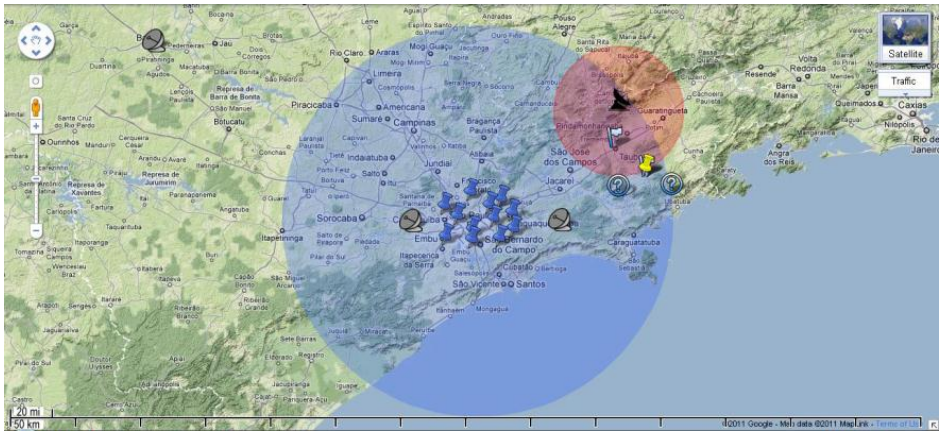
Courtesy, Tom Keenan BoM

# CHUVA Ground Validation IOP Sao Paulo, Brazil 2011-2012



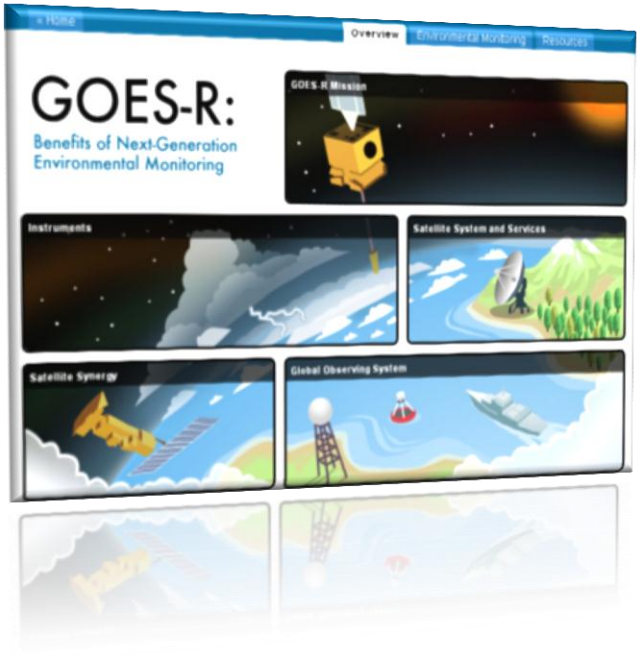


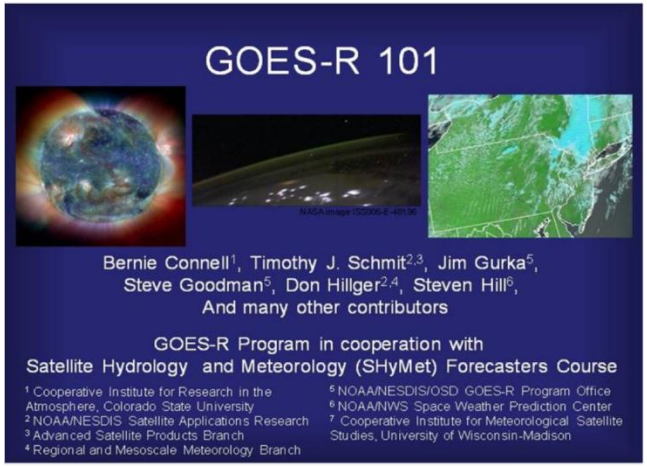
- **Field Campaign**
  - Leverage observing assets associated with CHUVA with U.S. supplied portable LMA network (and European supplied LINET) to generate proxy data sets for GLM and ABI that include total lightning (LIS and ground-based) and SEVIRI.
  - Allow GLM and Combined AWG/Science teams to better address and assess several areas of on-going research
- **Science Objectives**:
  - Algorithm and Proxy Data Validation
  - Validation Systems Performance Assessment
  - Storm Electrification/Physics
  - Nowcasting, Applications for GLM+ABI+…
- **Key scientific measurements:** VHF 3-D Lightning Mapping Array (LMA), LINET, TRMM/LIS, MSG SEVERI (ABI proxy data), high speed digital video, VLF lightning networks, dual-pol radar, electric field change, airplane in-situ microphysics




12-station LMA and radar sites

# Training and Education






## Online training modules

- http://meted.ucar.edu/goes_r/envmon/
- http://cimss.ssec.wisc.edu/satmet/
- http://rammb.cira.colostate.edu/visit/video/goesr101/player.html
- http://rammb.cira.colostate.edu/training/shymet/forecaster_intro.asp

*New- MetED -* ***Satellite Meteorology: GOES Channel Selection, 2nd Edition***

# Training and Education

- COMET Summer Faculty Course (Stan Kidder)

  - "Integrating Satellite Data and Products into Geoscience Courses with Emphasis on Advances in Geostationary Satellite Systems" Aug. 8-12, 2011
  - 34 applications, selected 24 faculty representing 24 different universities

- Outreach Projects (Eric Bruning, Scott Rudlosky)

  • COMET will reach out to the GOES-R Proving Ground Partners and connect them with university faculty to use current and prototype data products for the purpose of building a bridge from products that are currently available to those that will become available when GOES-R is launched.

  • The collaboration builds strong ties between the research and operational communities, and it is shown to improve performance at local forecast offices.